Pitfalls of location choice analysis : the finished goods producer versus the intermediate goods producer

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Abstract

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1 Introduction

A large number of studies have included empirical investigations of the role of agglomeration benefits such as demand linkages and cost linkages in firm location choice by using various kinds of proxy variables. Of recent interest are: Castellani and Zanfei (2004), Head and Mayer (2004), and Basile, Castellani, and Zanfei (2008). In these studies, GDP or market potential (sum of distance-weighted GDP) introduced by Harris (1954) has been used as a proxy for demand linkages, and total production values, value-added, or the number of firms in each industry have been used as proxies for cost linkages. These studies have consistently shown coefficients to be significantly positive.

Head and Mayer (2004) examined the validity of ready-made proxy variables for demand linkages compared with market potential measures directly derived from the new economic geography model (also known as Krugman's model). Such measures take into account the extent of competition and are constructed by using estimators of importing country dummy variables in the well-known gravity equation. However, they find that the "theory doesn't pay" in the sense that Harris market potential outperforms Krugman's market potential in both magnitude of coefficient and fit of the estimated model.

This paper includes consideration of different aspects on demand and costs linkages from Head and Mayer (2004) such as type of producers (for example, finished or intermediate goods producers). Despite the fact that estimation equations are derived from the model of finished goods producers, producer types are generally not considered in the selection of sample. This paper shows that the use of equations derived from such models against intermediate goods producers results in several problems. Section 2 includes derivation of profit functions of finished and intermediate goods producers from the standard model found in the literature related to location choice. Problems encountered in analyzing location choice without distinguishing producer types are discussed in Section 3.

2 Location Choice Model

Profit functions of finished and intermediate goods producers from the standard model are presented in this section. In the finished goods sector, the well-employed model found in location choice studies such as that of Head and Mayer (2004) is followed. The intermediate goods sector, which is formulated by following the standard new economic geography model (Krugman and Venables, 1995) is incorporated.

2.1 Finished Goods Producers

A representative consumer in each region is assumed to have a two-tier utility function. The upper tier is a Cobb-Douglas function of the utility derived from consumption of finished goods. Specifically, the following utility function of the consumer in region r is applied:

$$U_r = \prod_{h=1}^{H} \left(C_r^h\right)^{\alpha_h}, \quad \sum_{h=1}^{H} \alpha_h = 1,$$

where C_r^h is the aggregate consumption of finished goods h in region r.

Expenditure allocation is formalized in finished goods consisting of multiple varieties omitting the subscript representing the name of finished goods. The consumer has the following preference specified as a constant elasticity of substitution (CES) function over varieties:

$$C_r = \left[\sum_{i=1}^{R} \int_0^{N_r} \left(\frac{x_{r,i}(j)}{t_{r,i}}\right)^{\frac{\sigma-1}{\sigma}} dj\right]^{\frac{\sigma}{\sigma-1}}$$

where R, N_r, and $x_{r,i}(j)$ are the number of countries, the number (mass) of finished varieties, and the demand of region r for finished varieties j produced in region i, respectively. Transactions in finished goods between regions r and s are modeled as facing Samuelsonian iceberg costs, $t_{r,s}(\geq 1)$. $t_{r,s} = 1$ if $r = s$. σ is the elasticity of substitution between finished varieties and is assumed to be greater than unity. The utility maximization yields:

$$x_{r,i} = \alpha t_{r,i}^{1-\sigma} p_i^{-\sigma} P_i^{\sigma-1} Y_r \tag{1}$$

where p_i and P_r denote the price of the variety produced in region i and the price index in region r, respectively (variety notation j is dropped where clarity permits). Y_r is total expenditure in region r.

The market structure in the finished goods sector is assumed to be a Chamberlinian monopolistic competition. The finished goods producer of each region is a combination of a composite index aggregated across varieties of intermediate inputs and primary factors such as labor and physical capital. This is based on a Cobb-Douglas model. The composite becomes a part of the cost function for each producer through a CES aggregator as follows:

$$C\left(x_r\right) = w_r^{1-\mu} G_r^{\mu} x_r + F_r, \quad G_r = \left[\int_0^{M_r} q_r\left(j\right)^{1-\nu} dj\right]^{\frac{1}{1-\nu}},$$

where w_r denotes the price index for primary factors that is employed by each finished goods producer in the production of total output x_r $(=\sum_i x_{r,i})$. G_r is the price index for intermediate goods, and F_r^F represents fixed costs. μ is a linkage parameter between finished and intermediate goods. M_r, $q_r(j)$, and ν are respectively the number (mass) of intermediate varieties produced in region r, the price of j-th varieties produced in region r, and the elasticity of substitution between intermediate goods, respectively. Elasticity is again assumed to be greater than unity. Note that for easy comparison of the profit function between finished and intermediate goods producers, the intermediate goods market is assumed to be segmented; transaction costs of intermediate goods across regions are prohibitively high. Each firm maximizes its profit with respect to quantity in order to derive producer prices:

$$p_r = \left(\frac{\sigma}{\sigma - 1}\right) w_r^{1-\mu} G_r^{\mu}. \tag{2}$$

Using (1) and (2), a profit function of a finished goods producer in region r may be derived as follows:

$$\pi_r^F = \alpha\sigma^{-\sigma}\left(\sigma - 1\right)^{\sigma-1} w_r^{(1-\mu)(1-\sigma)} G_r^{\mu(1-\sigma)} \left[\sum_{i=1}^{R} t_{i,r}^{1-\sigma} P_i^{\sigma-1} Y_i\right] - F_r.$$

The second bracket of the RHS, $\sum_{i=1}^{R} t_{i,r}^{1-\sigma} P_i^{\sigma-1} Y_i$, will hereafter be called "market potential" and denoted by MP_r. The profit function may thus be rewritten as follows:

$$\pi_r^F = \alpha\sigma^{-\sigma}\left(\sigma - 1\right)^{\sigma-1} w_r^{(1-\mu)(1-\sigma)} G_r^{\mu(1-\sigma)} MP_r - F_r^F. \tag{3}$$

2.2 Intermediate Goods Producers

In the case of location choice of intermediate goods producers, the profit function (3) qualitatively changes. Considering the production technology with horizontal linkages (see for example Krugman and Venables, 1995), intermediate goods are produced not only with primary factors but also with intermediate goods themselves. As in the finished goods producer, the intermediate goods producer of each region combines a composite index aggregated across varieties of intermediate inputs and primary factors using a Cobb-Douglas model. The composite becomes a part of the cost function for each producer through a CES aggregator:

$$C(z_r) = w_r^{1-\lambda} G_r^{\lambda} z_r + F_r^I,$$

where z_r denotes total output of an intermediate variety produced in region r, and λ is a linkage parameter among intermediate goods. F^I denotes fixed costs. Then the profit function is given by:

$$\pi_r^I = \nu^{-\nu} (\nu - 1)^{\nu-1} w_r^{(1-\nu)(1-\lambda)} G_r^{\lambda(1-\nu)} \left[\sum_{i=1}^{R} \tau_{i,r}^{1-\nu} G_i^{\nu-1} (\mu X_i + \lambda Z_i) \right] - F_r^I,$$

where τ denotes iceberg costs. X_i is equal to $N_i p_i \sum_r x_{r,i}$. Z_i is equal to $M_i q_i z_i$. In this case, the composition of demand linkages becomes comlex. The magnitude of intermediate as well as finished goods production is positively related to the profit of plants producing intermediate goods. Assuming prohibitively high ice-berg costs, the following is obtained:

$$\pi_r^I = \nu^{-\nu} (\nu - 1)^{\nu-1} w_r^{(1-\nu)(1-\lambda)} G_r^{(\lambda-1)(1-\nu)} (\mu X_i + \lambda Z_i) - F_r^I. \tag{4}$$

3 Pitfalls

Most previous studies have explicitly or implicitly considered location choice of finished goods producers and estimated their profit function as in (3) by using conditional logits. In profit function (3), F_r^F is assumed to be identical for tractability across regions as seen in Head and Mayer (2004). As monotonic transformations leave ordering of profit unchanged, the finished goods producer chooses the region in which the following log-function is maximized:

$$\begin{aligned} \ln \Pi_r &= V_r + \varepsilon_r \\ &= (1-\mu)(1-\sigma)\ln w_r + \mu(1-\sigma)\ln G_r + \ln MP_r + \varepsilon_r \end{aligned} \tag{5}$$

where ε_r denotes unobservable regional characteristics.

Although producer types are usually not considered in the selection of sample, the use of equation (5) for intermediate goods producers results in several problems: First, the powers of w_r and G_r in function (4) are different from those in function (3). In particular, while the power of G_r is positive in function (4), it is negative in function (3). This asymmetry implies that the magnitude of its coefficient may suffer from a serious aggregation bias when equation (5) is applied to intermediate goods producers. Second, from a qualitative point of view, unlike its role in function (3), G_r in function (4) plays a role in capturing a part of demand linkages rather than cost linkages. The small G_r in function (4) implies bad access to input markets rather than existence of many competitors. This results in lower operating profit. Third, considering function (4), the demand component $\mu X_r + \lambda Z_r$ is not log-linearly related to MP_r. This leads to an errors-in-variable problem and results in inconsistency of estimators. This emerges in estimating equation (5) for location choice of intermediate goods producers.

A more appropriate procedure would be to separately estimate equation (5) for finished goods producers and the equation based on (4) for intermediate goods producers. In both cases, wage data are usually available, but there is a limitation of data related to the price index for intermediate goods G. In the literature, the variable reflecting magnitude of agglomeration (total production values in each industry) is often used. From a theoretical point of view, the price index for intermediate goods is low in regions with such large agglomerations, so this proxy is somewhat plausible. Variables related to demand linkages (MP_r or $\mu X_r + \lambda Z_r$) are also troublesome. In the case of finished goods producers, (sum of distance-weighted) Gross Domestic Expenditure becomes a good proxy for MP since consumers of finished goods are all people living in the region. On the other hand, in the case of intermediate goods producers, the total production values of finished goods and those of intermediate goods are good proxies though non-linear estimation techniques are necessary in estimating the profit function. In addition, the use of a direct measure such as the expenditure on intermediate goods in the region may be better than those variables. In either case, those data are difficult to obtain, and the input-output table seems to be the only source. If the sample covers many regions, such data are likely to be unavailable.

In sum, the estimation of equation (5) for the location choice of intermediate goods producers yields an errors-in-variable problem, and this makes estimators inconsistent. In addition, the magnitude of some coefficients suffers from aggregation bias and difficulty in interpretation. To strictly analyze the location choice of intermediate goods producers, relatively unobtainable data is necessary including total production values of finished goods and intermediate goods.

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